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# EXHAUST CONTROL SYSTEM FOR TWO-STROKE ENGINE

## Abstract

An exhaust control system for a two-stroke engine is disclosed, wherein the cross-sectional area of an exhaust is controlled in accordance with the rotational speed of the engine by opening and closing at least one auxiliary exhaust passage with respect to a main exhaust passage. The main exhaust passage and the auxiliary exhaust passage connected to a cylinder are located parallel to each other circumferentially of the cylinder, and a rotary valve in the form of a shaft disposed parallel to the centerline of the cylinder is operative to open and close the auxiliary exhaust passage with respect to the main exhaust passage in accordance with an increase and a decrease in the engine speed.

What is claimed is:

1. An exhaust control system for a two-stroke engine, characterized by comprising:

a main exhaust passage;

at least one auxiliary exhaust passage disposed at one side of the main exhaust passage in the circumferential direction of a cylinder;

at least one rotary valve for adjustably opening and closing the auxiliary exhaust passage, the rotary valve being in the form of a shaft located parallel to the centerline of the cylinder and interposed between the main exhaust passage and the auxiliary exhaust passage for rotation,

wherein the auxiliary exhaust passage remains in a closed state with respect to the main exhaust passage when the engine operates at a low speed, and is successively opened with respect to the main exhaust passage as the speed of the engine increases.

Description

This invention relates to an exhaust control system for a two-stroke engine used in a motorcycle and the like.

FIG. 1 is a vertical sectional view of a two-stroke engine incorporating a first embodiment of the exhaust control system of the present invention;

FIGS. 2 and 3 are sectional views taken along the line II--II in FIG. 1, depicting the two-stroke engine shown in FIG. 1 in a low engine speed range and in a high engine speed range, respectively;

FIG. 4 is a sectional view taken along the line IV--IV in FIG. 1;

FIG. 5 is a sectional view taken along the line V--V in FIG. 4;

FIGS. 6 and 7 are transverse sectional views taken along the lines II--II and IV--IV, respectively, in FIG. 1 and showing a two-stroke engine incorporating a second embodiment of the exhaust control system of the present invention;

FIG. 8 is a vertical sectional view of an exhaust control system of the prior art for a two-stroke engine.

FIG. 8 shows an exhaust control system of the prior art for a two-stroke engine, which comprises a main exhaust passage 1, an auxiliary exhaust passage 2 and a rotary valve 3 having a shaft disposed normal to the centerline 0 of the cylinder of the engine. The rotary valve 3 is operative to open and close the auxiliary exhaust passage 2 with respect to the main exhaust passage 1. More specifically, the rotary valve 3 successively opens the auxiliary exhaust passage 2 with respect to the main exhaust passage 1 as the engine speed increases so as to achieve a high output power of the engine by causing the cross-sectional area of an exhaust of the engine to match the engine characteristic in the

high engine speed range.

The exhaust control system of the prior art of the aforesaid construction would suffer the disadvantages that since the rotary valve 3 is disposed normal to the centerline of the cylinder, difficulties are experienced in arranging the auxiliary exhaust passage 2 at one side of the main exhaust passage 1 disposed circumferentially of the cylinder, and great limitations are placed on the area of opening of the rotary valve 3.

This invention has been developed for the purpose of obviating the aforesaid disadvantages of the prior art. Accordingly, it is an object of the invention to provide an exhaust control system for a two-stroke engine capable of providing a high output power of the engine in a high engine speed range while enabling rotary valves for opening and closing auxiliary exhaust passages to have an opening of an area large enough to perform an auxiliary exhaust passage opening and closing operation satisfactorily.

In the exhaust control system according to the invention, at least one auxiliary exhaust passage is formed at one side of a main exhaust passage circumferentially of a cylinder of the engine, and at least one rotary valve, which is in the form of a shaft parallel to the centerline of the cylinder for adjustably opening and closing the auxiliary exhaust passage, is rotatably mounted between the main exhaust passage and the auxiliary exhaust passage. The rotary valve operates such that it closes the auxiliary exhaust passage with respect to the main exhaust passage when the engine is in a low speed range and it successively opens the auxiliary exhaust passage with respect to the main exhaust passage as the engine speed increases, to thereby form a cross-sectional area of an exhaust matching the engine characteristic in a high engine speed range.

Other objects, features and advantages of the invention will become apparent from the following description of preferred embodiments.

Referring to FIG. 1, a cylinder 10 has a piston 12 slidably fitted therein, and is formed with a suction passage 13, a scavenging passage 14 and a main exhaust passage 15. The suction passage 13 is provided with a reed valve and opened and closed as the piston 12

slides upwards and downwards with respect to a crank chamber 8 enclosed by a crank case. The scavenging passage 13 opens at its lower end in the crank chamber and has its upper end opened and closed as the piston 12 slides upwards and downwards with respect to the cylinder 10.

Referring to FIG. 2 which is a sectional view taken along the line II--II in FIG. 1, a first auxiliary exhaust passage 16 and a second auxiliary exhaust passage 17 are located at opposite sides of the main exhaust passage 15 disposed circumferentially of the cylinder 10. The first and second auxiliary exhaust passages 16 and 17 independently open at one end thereof in the cylinder 10, and a first rotary valve 18 and a second rotary valve 19 for adjustably opening and closing the first auxiliary exhaust passage 16 and second auxiliary passage 17, respectively, at the other end thereof, are mounted to bring the auxiliary exhaust passages 16 and 17 into and out of communication with an intermediate portion of the main exhaust passage 15.

The two rotary valves 18 and 19 are each in the form of a shaft located parallel to the centerline of the cylinder 10 and supported by a valve seat 25 of the cylinder 10 for rotation. The rotary valves 18 and 19 are formed with cutout passages 26 and 27, respectively.

Referring to FIG. 4, the rotary valves 18 and 19 are located at one side of a rack shaft 28 and have pinions 31 and 32, respectively, to provide unitary structures. The pinions 31 and 32 are maintained in meshing engagement with respective serrations of the rack shaft 28 which is supported by boss 35 for movement in an axial direction and extends into a transmission box 36. A portion of the rack shaft extending into the transmission box 36 has a pair of adjusting plates 37, and a vertical pin 39 of a pivotal arm 38 extends between the two adjusting plates into engagement therewith. The pivotal arm 38 is secured to a rotary vertical shaft 40.

The rotary vertical shaft 40 is coupled to a lower end of an arm 42 having a vertical pin 41 which is held between a pair of annular adjusting plates 44 of a slider 43. The slider 43 is fitted over a governor rotary shaft 45 for axial sliding movement. The axial sliding

movement of the slider 43 causes the rotary vertical shaft 40 to rotate via the adjusting plates 44, the vertical pin 41 and the arm 42.

In FIG. 5 which is a sectional view taken along the line V--V in FIG. 4, a governor 30 comprises a pair of dish-shaped concave-surface plates 46 and 47, a plurality of centrifugal balls 48 held between the dish-shaped concave-surface plates 46 and 47 and a governor spring 49 to constitute what is usually referred to as centrifugal ball type governor means. The concave-surface plate 47 is formed integrally with the slider 43 described hereinabove. The governor spring 49 which is mounted in compressed condition between the adjusting plate 44 and a governor drive gear biases the concave-surface plate 47 in a direction opposite the direction indicated by an arrow E via the adjusting plate 44. The governor drive gear 51 is coupled to the governor rotary shaft 45, journalled by a bearing 57, and meshes with a crank gear 56 of a crankshaft 55. The rotary vertical shaft 40 is supported by a boss member 58 for rotation.

The operation of the first embodiment of the exhaust control system constructed as described hereinabove will be described. When the engine operates at a low speed, no great centrifugal forces act on the centrifugal balls shown in FIG. 5 and the slider 43 does not move in sliding movement in the direction indicated by the arrow E. This keeps the two rotary valves 18 and 19 in a condition shown in FIG. 2 in which the auxiliary exhaust passages 16 and 17 are fully closed with respect to the main exhaust passage. Thus, the cross-sectional area of the exhaust from the cylinder 10 is equal to the cross-sectional area of the main exhaust passage at this time, which matches the characteristic of the engine operating at a low speed.

As the engine speed increases, the rotational speed of the governor rotary shaft 45 shown in FIG. 5 also increases. This causes the centrifugal forces exerted on the balls 48 to increase until they overcome the biasing force of the governor spring 49, forcing the slider 43 which is integral with the concave-surface plate to slide in the direction indicated by the arrow E. This sliding movement of the slider 43 causes, via the pin 41 and the arm 42 shown in FIG. 4, the rotary vertical shaft 40 to rotate in a direction indicated by an arrow D in FIG. 4, to thereby cause, via the arm 38 and the pin 39, the

rack shaft 28 to shift in a direction indicated by an arrow in FIG. 4. The movement of the rack shaft 28 in the direction indicated by the arrow C causes the two rotary valves 18 and 19 shown in FIG. 2 to rotate in directions indicated by respective arrows A in FIG. 2, so that the two auxiliary exhaust passages 16 and 17 are successively opened with respect to the main exhaust passage 15.

Thus, the exhaust area of the cylinder 10 which is equal to the cross-sectional area of the main exhaust passage 15 when the engine operates at a low speed gradually increases as the cross-sectional areas of open portions of the two auxiliary exhaust passages 16 and 17 increase, until it becomes equal to the cross-sectional area of the main exhaust passage 15 plus the cross-sectional areas of the two auxiliary exhaust passages 16 and 17 and matches the characteristics of the engine operating at a high speed. This is conducive to improved output power of the engine.

More specifically, when the engine overruns or operates at the highest speed, the two auxiliary exhaust passages 16 and 17 are fully open with respect to the main exhaust passage 15 as shown in FIG. 3, with a result that the cross-sectional area of the exhaust from the cylinder 10 which becomes equal to the cross-sectional area of the main exhaust passage 15 plus the cross-sectional areas of the two auxiliary exhaust passages 16 and 17 is maximized and matches the characteristic of the engine overrunning or operating at the highest speed. With the two auxiliary exhaust passages 16 and 17 on opposite sides of the main exhaust passage 15 being fully open, control of the exhaust performed by the exhaust control system according to the invention achieves excellent effects in increasing the output power of the engine.

Let us now describe a second embodiment shown in FIG. 6 in which an expansion chamber 21 is communicated with a first expansion passage 23 and a second expansion passage 24 of the cylinder 10 which in turn are communicated with the main exhaust passage 15 through the rotary valves 18 and 19 which can be opened and closed. As shown in FIG. 7, the valves 18 and 19 are located on opposite sides of the rack shaft 28. Thus, as the rack shaft 28 shifts in the direction indicated by the arrow C, the first rotary valve 18 rotates in the direction indicated by the arrow A while the second rotary valve 19

rotates in the direction indicated by the arrow A'. The result of this is that the auxiliary exhaust passages 16 and 17 are closed with respect to the main exhaust passage 15 while the expansion chamber 21 communicates with the main exhaust passage 15 as shown in FIG. 6.

In the second embodiment of the construction shown in FIG. 6, the expansion chamber 21 is fully open with respect to the main exhaust passage 15 via the passages 23 and 24 when the engine operates at a low speed. This makes it possible for the expansion chamber 21 to absorb pulsations occurring in the exhaust passages, thereby improving the output power of the engine operating at the low speed. The expansion chamber 21 is successively closed as the rotational speed of the engine increases, and the pulsations in the exhaust passages are gradually reduced with an increase in the rotational speed of the engine. Thus, an increase in the pulsation can be avoided.

In the embodiments shown in FIGS. 1-6, the system has been described as having two auxiliary exhaust passages. However, the invention is not limited to this specific number of the auxiliary exhaust passages and the number of the auxiliary exhaust passages may be one or three or more. The number of the rotary valves should also be altered to correspond to the number of the auxiliary exhaust passages.

The invention can achieve the following effects. When the engine operates at a low speed, the auxiliary exhaust passages remain closed, so that the exhaust has a small cross-sectional area. However, as the rotational speed of the engine increases, the auxiliary exhaust passages are gradually opened and the cross-sectional area of the exhaust successively increases until the cross-sectional area of the exhaust is maximized when the two auxiliary exhaust passages are both fully open as the engine overruns or operates at the highest speed. When this condition is achieved, the characteristic of the engine is substantially stabilized and the output power of the engine is markedly improved because of the fact that effective use can be made of the auxiliary exhaust passages when the engine operates at a high speed.

In the system according to the invention, the rotary valves for opening and closing the

auxiliary exhaust passages with respect to the main exhaust passage are each in the form of a shaft and located in parallel to the centerline of the cylinder of the engine. This arrangement enables the area of the opening of each of the rotary valves to be increased with ease as compared with the arrangement of the rotary valve in the prior art shown in FIG. 8 whereby the rotary valve is located normal to the centerline of the cylinder in a position above the main exhaust passage. More specifically, in the system according to the invention, no difficulties are experienced in increasing the diameter of the rotary valves and the axial length of the cutout passages of the rotary valves to increase the area of the opening of each of the rotary valves. An increase in the area of the opening of each rotary valve is conducive to increased efficiency in the use of auxiliary exhaust passages.

In the system according to the invention, the auxiliary exhaust passages are located at opposite sides of the main exhaust passage circumferentially of the cylinder. This arrangement prevents the occurrence of a change in the compression ratio of a fuel-air mixture in the cylinder which might otherwise occur when the auxiliary exhaust passages are opened. Thus, the compression ratio can be kept at a high level even when the engine operates at a high speed, thereby increasing the characteristic of the engine in the high engine speed range.

After the specific embodiments have been described, it is obvious that modifications and variations of the invention are possible in light of the above teachings.

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〔57〕摘要

二冲程发动机的排气控制系统，根据发动机的转速对至少一个辅助排气道相对于主排气道的开启和关闭来控制排气的截面积，与气缸连接的主排气道和辅助排气道彼此与气缸圆周向并列配置，与气缸中心线并列配置的呈轴形的回转阀工作时能根据发动机速度的增大和减小相对于主排气道开启和关闭辅助排气道。



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# 权　利　要　求　书

二冲程发动机的排气控制系统，其特征在于：

一个主排气道；

在气缸圆周向主排气道的一侧至少配置一个辅助排气道；

至少有一个能使辅助排气道可调节式开启和关闭的回转阀，轴形的回转阀与气缸中心线呈并列配置并位于主排气道和辅助排气道之间，可以转动；

发动机低速运转时，辅助排气道相对于主排气道保持关闭状态，随着发动机速度加快，辅助排气道相对于主排气道逐渐开启。

# 说　　　　明　　　　书

## 二冲程发动机的排气控制系统

本发明是关于供摩托车等用的二冲程发动机排气控制系统。

图1为配有本发明的第一个排气控制系统实施例的二冲程发动机的纵剖面图；

图2和图3为图1中沿II—II线的剖面图，分别表示在低速和高速范围图1中所示的二冲程发动机；

图4为图1中沿IV—IV线的剖面图；

图5为图4中沿V—V线的剖面图；

图6和图7为图1中沿II—II和IV—IV线的横向剖面图，且示出了配有本发明的第二个排气控制系统实施例的二冲程发动机；

图8为现有技术的二冲程发动机排气控制系统的纵剖面图。

图8示出了现有技术的二冲程发动机排气控制系统，该系统包含主排气道*1*、辅助排气道*2*和其轴相对于发动机气缸中心线*0*为垂直配置的回转阀*3*。回转阀*3*工作时，能相对于主排气道*1*使辅助排气道*2*开启和关闭。具体地说，当发动机速度增大时，回转阀*3*能相对于主排气道*1*使辅助排气道*2*逐渐开启，以便通过引成与发动机高速范围的发动机特性相匹配的发动机排气截面的办法获得发动机高的输出功率。

现有技术所公开的上述结构的排气控制系统存在的问题是：回转阀*3*与气缸中心线垂直配置，致使辅助排气道*2*难以布置在位于气缸圆周向配置的主排气道*1*的一侧，大大限制着回转阀*3*的孔口面积。

本发明是为了消除现有技术的上述不足而作出的改进，本发明的目的是提供一种二冲程发动机的排气控制系统，这种排气控制系统能在发动机高速运转范围内给出高的发动机输出功率，能使开启和关闭辅助排气道的回转阀具有足够大的孔口面积以满意地执行辅助排气道的开启和

关闭的动作。

本发明的排气控制系统，在发动机气缸圆周向配置的主排气道一侧至少有一个辅助排气道，在主排气道和辅助排气道之间至少装有一个可转动的与气缸中心线并列的能调节式开启和关闭辅助排气道的呈轴形的回转阀。该回转阀工作时，能在发动机低速运转范围内相对于主排气道使辅助排气道关闭，能在发动机速度增大时相对于主排气道使辅助排气道逐渐开启以借此形成与发动机高速运转范围内的发动机特性相匹配的排气截面。

本发明的其它目的、特征和优点通过对最佳实施例的下列说明会更加清楚明瞭。

参照图1，气缸１０内有滑动配合的活塞１２、进气道１３、扫气道１４和主排气道１５。进气道１３有一个簧片阀并通过活塞１２相对于曲轴室8的上下滑动而被开启和关闭，该曲轴室是由曲轴箱封住的。扫气道１３的下端在曲轴室内开启，上端通过活塞１２相对于气缸１０的上下滑动而被开启和关闭。

参照图2，它是图1中沿II—II线的剖面图。在气缸１０圆周向配置的主排气道１５相对的两侧是第一辅助排气道１６和第二辅助排气道１７。第一和第二辅助排气道１６和１７在气缸１０中有一端是独自开启的，另一端有各自的可使第一辅助排气道１６和第二辅助排气道17调节式开启和关闭的第一回转阀１８和第二回转阀１９。这两个回转阀使辅助排气道１６和１７与主排气道１５的中间部位接通和切断。

这两个回转阀１８和１９均做成轴的形式，与气缸１０的中心线并列且由气缸１０的阀座２５支承，可以转动。回转阀１８和１９有各自的切口通道２６和２７。

参照图4，回转阀１８和１９装在齿条轴２８的一侧且有各自的齿

轮3 1和3 2，具有相同的结构。齿轮3 1和3 2分别与齿条轴2 8的细齿保持啮合，齿轮轴架在轴座3 5上可以作轴向移动且伸到传动箱36中。伸进传动箱3 6内的部分有一对调节板3 7，摇臂3 8的立销3 9插在两个调节板中间形成配合。摇臂3 8固定在回转立轴4 0上。

回转立轴4 0联着臂4 2的下端，下端的立销4 1夹在滑块4 3的一对环形调节板4 4之间，滑块4 3装在调速器转轴4 5上作轴向滑动。滑块4 3的轴向滑动，通过调节板4 4、立销4 1和臂4 2带动回转立轴4 0转动。

图5是图4中沿V—V线的剖面图。调速器3 0有一对碟形凹面板4 6和4 7、碟形凹面板4 6和4 7之间的多个离心球4 8和一个通称为离心球式调速器的调速器弹簧4 9，凹面板4 7与上面介绍的滑块4 3组成一个整体结构。压在调节板4 4和调速器驱动装置之间的调速器弹簧4 9，通过调节板4 4的作用，使凹面板4 7朝箭头E所指示的相反方向偏置。调速器驱动装置5 1由轴承5 7与调速器转轴4 5的轴颈联接，并与曲轴5 5的曲柄齿5 6啮合。回转立轴4 0架在轴座5 8上，可以转动。

现在说明一下上述结构的第一个排气控制系统实施例的工作情况。当发动机低速运转时，图5所示的离心球不承受多大的离心力，滑块43不会沿箭头E的方向滑动，这时两个回转阀1 8和1 9处于图2所示的状态，辅助排气道1 6和1 7相对于主排气道是完全关闭的。这样，气缸1 0的排气截面积相同于此时主排气道的截面积，与发动机低速运转时发动机特性相匹配。

发动机速度加快时，图5中所示的调速器转轴4 5的转速也增加，这就使得施于球4 8上的离心力增大到克服调速器弹簧4 9的偏置压力，迫使与凹面板成整体结构的滑块4 3沿着箭头E所示方向滑动。滑块43

的滑动通过在图4中所示的销4 1和臂4 2带动回转立轴4 0沿图4箭头D所示的方向转动，进而通过臂3 8和销3 9带动齿条轴2 8沿图4箭头所指方向移动。齿条轴2 8沿箭头C所指方向的移动带动图2所示的两个回转阀1 8和1 9分别沿图2箭头A所指方向转动，使两个辅助排气道1 6和1 7相对于主排气道1 5逐渐开启。

这样一来，气缸1 0的排气面积（等于主排气道1 5的截面积）在发动机低速运转时随着两个辅助排气道1 6和1 7开启部分截面积的增大而逐渐加大到主排气道1 5和两个辅助排气道1 6和1 7截面之和，与发动机高速运转时的发动机特性相匹配，从而使发动机的输出功率提高。

具体地说，在发动机超速或以最高速运转时，两个辅助排气道1 6和1 7相对于如图3中所示的主排气道1 5是完全开启的，其结果是气缸1 0的排气截面积达到主排气道1 5和两个辅助排气道1 6和1 7的面积之和的最大值，与发动机超速或最高速度运转时的发动机特性相匹配。由于主排气道1 5相对两侧的两个辅助排气道1 6和1 7是完全开启的。利用本发明的排气控制系统进行排气控制对提高发动机的输出功率具有良好的效果。

现在让我们说明一下在图6中所示的第二个实施例。膨胀室2 1与气缸1 0的第一膨胀通道2 3和第二膨胀通道2 4接通，又经过能开启和关闭的回转阀1 8和1 9与主排气道1 5接通。正如图7中所指出的，回转阀1 8和1 9是配置在齿条轴2 8的相对的两侧，因此，齿条轴28沿箭头C所指方向移动时，第一回转阀1 8沿箭头A所指方向转动，第二回转阀1 9同时沿箭头A' 所指方向转动，其结果是辅助排气道1 6和1 7相对于主排气道1 5关闭，膨胀室2 1同时与图6所示的那样和主排气道1 5接通。

在图6示出的第二个实施例的结构中，当发动机低速运转时，膨胀室２１经过通道２３和２４相对于主排气道１５是完全开启的，这就使膨胀室２１有可能吸收在排气道中产生的波动，从而提高发动机低速运转时的输出功率。膨胀室２１是随着发动机转速的增大而逐渐被关闭的，而且排气道中的波动随发动机转速的增加而减小，因此，波动的增加是能够避免的。

在图１—６中所示的实施例中，介绍了带有两个辅助排气道的系统。但是，本发明是不局限于辅助排气道的具体数量，它可以是一个或三个或多个。回转阀的数量也应随辅助排气道的数量作相应的变更。

本发明能够获得下列效果。在发动机低速运转时，辅助排气道保持关闭状态使排气具有小的截面积，但在发动机转速增大时，辅助排气道逐渐开启并使排气截面积逐渐增大到发动机超速或最大速度运转时两个辅助排气道全开启的最大排气截面积。在这种情况下，发动机的性能非常稳定，而且因发动机高速运转时辅助排气道得到了有效的利用而使发动机的输出功率有显著的提高。

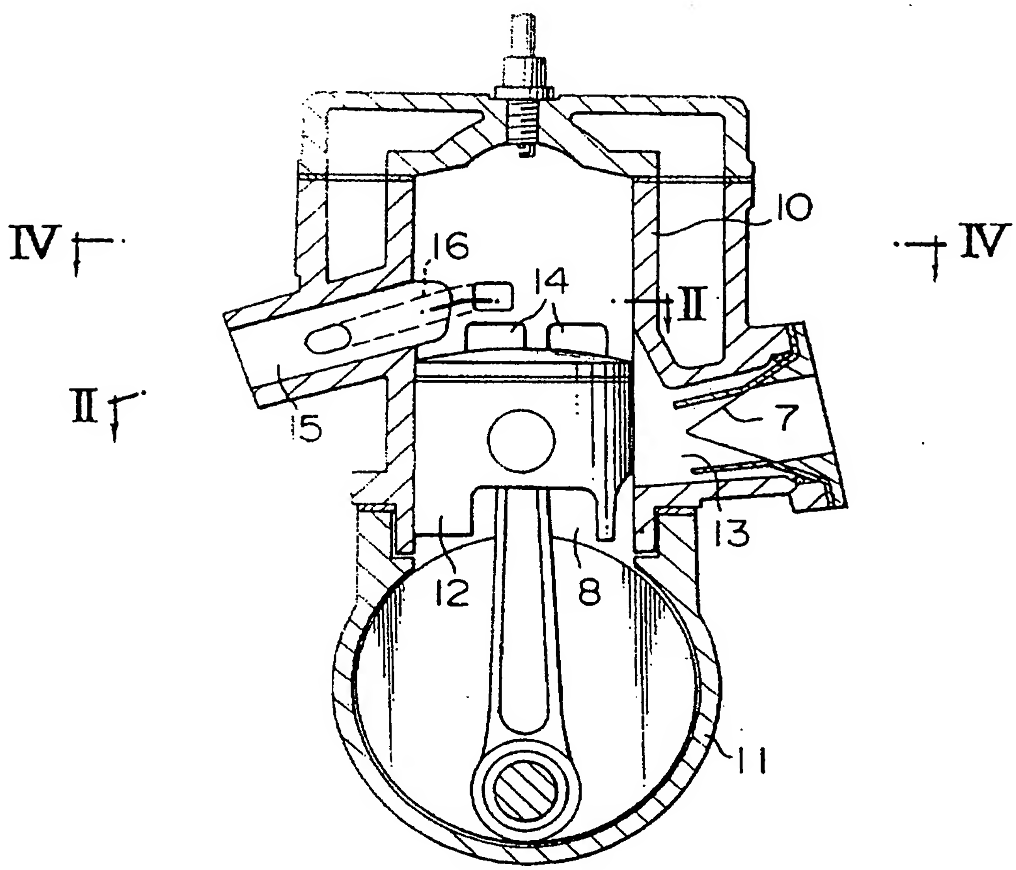
在本发明的系统中，使辅助排气道相对于主排气道能开启和关闭的回转阀均做成轴的形式且与发动机气缸呈并列配置，比起图8中所示的现有技术所公开的与气缸中心线呈垂直配置在主排气道上方位置的回转阀装置来说，本发明的布局易于使每个回转阀的孔口面积增大。具体一点讲，在本发明的系统中，增加回转阀的直径和回转阀切口通道的轴向长度以增加每个回转阀的孔口面积是毫无困难的。每个回转阀孔口面积的增大也就提高了辅助排气道的使用效率。

在本发明的系统中，辅助排气道配置在气缸圆周向主排气道的相对的两侧，这样的布置防止了在其它情况下辅助排气道被开启时可能发生的气缸中燃油空气混合物的压缩比的变化。因此，即使发动机高速运转

时也能保持很高的压缩比，从而提高了发动机高速特性。

显而易见，对具体的实施例进行说明以后，根据上述构思的启发对本发明作改进和变型是有可能的。

图.1



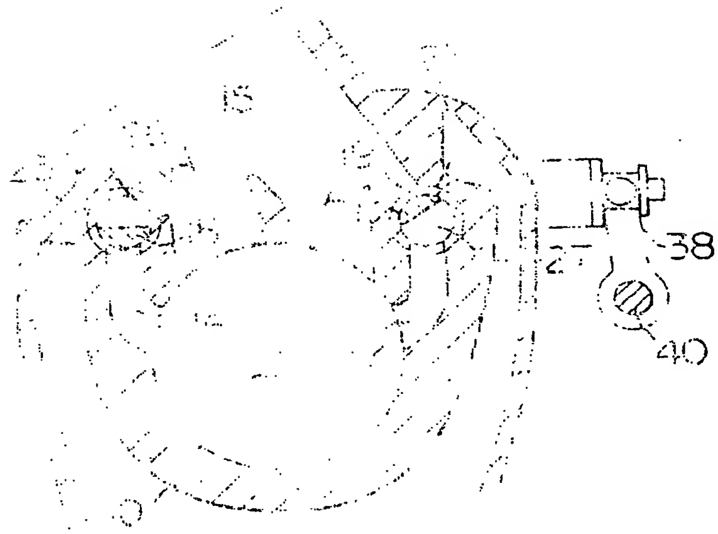



図 3

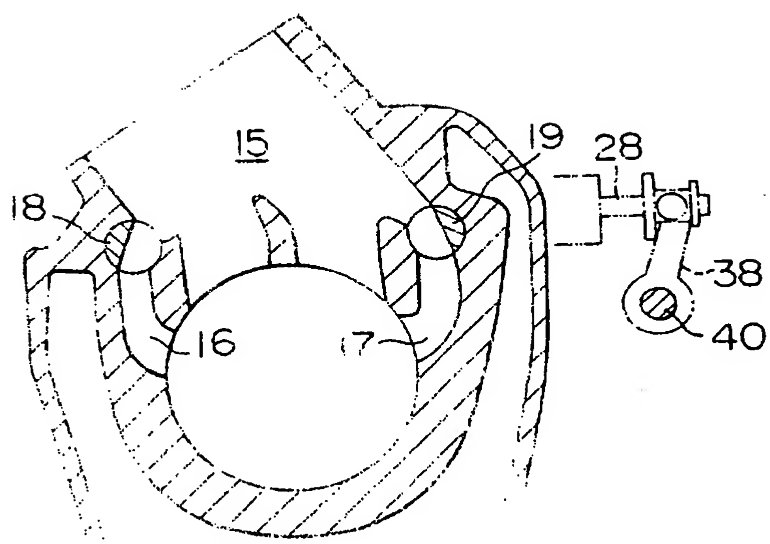


图. 4

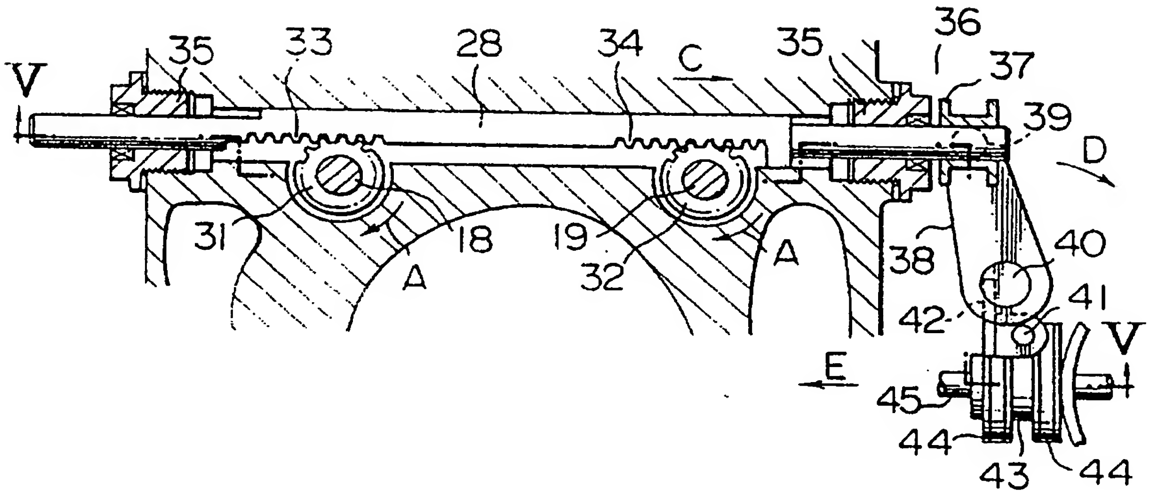
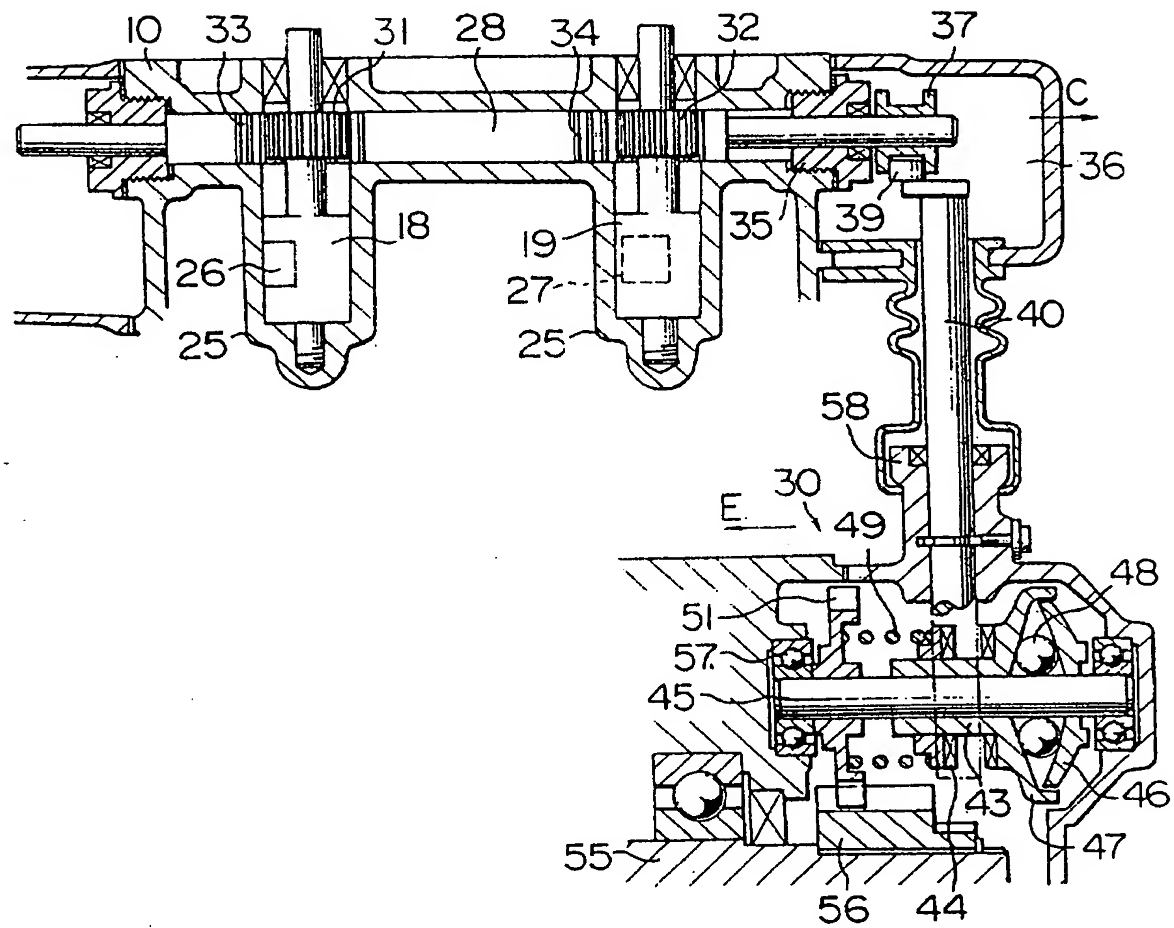


図. 5



10
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C
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18
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27
25
25
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58
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E
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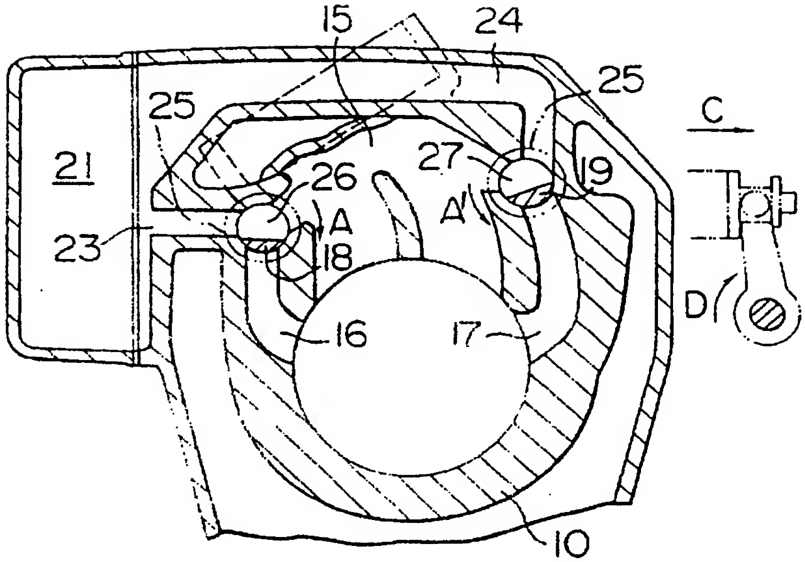
図.6


15
24
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25
C
21
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27
19
A
A'
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D
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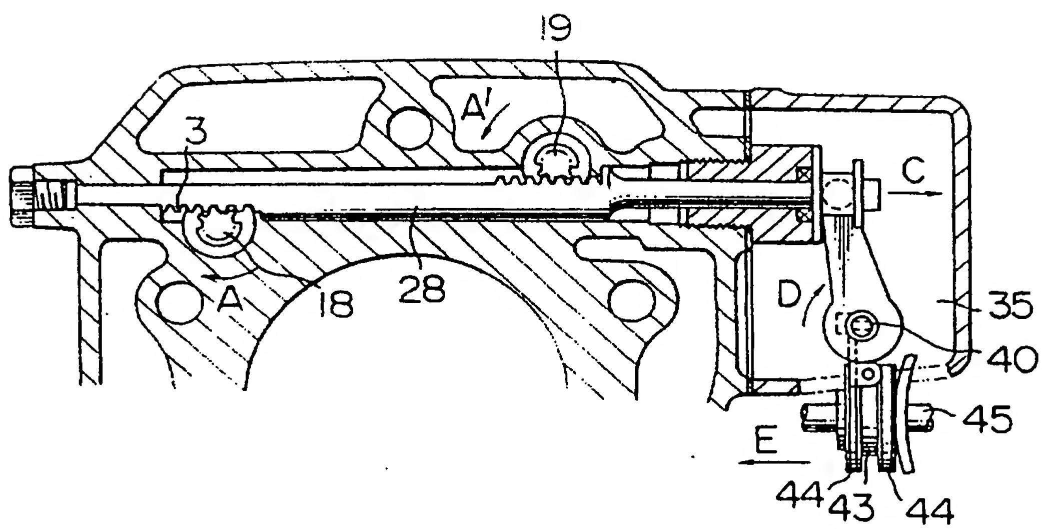
17
10

図.7


19
A'
3
C
D
35
A
18
28
40
45
E
44
43
44